

CLAIMS

What is claimed is:

1. A method, comprising:

5 providing a first signal from a first acoustic sensor and a second signal from a second acoustic sensor spaced apart from the first acoustic sensor, the first signal and the second signal each corresponding to two or more acoustic sources, said acoustic sources including a plurality of interfering sources and a desired source;

10 localizing the interfering sources from the first and second signals to provide a corresponding number of interfering source signals each corresponding to a different one of the interfering sources and each including a plurality of frequency components, the components each corresponding to a different frequency; and

15 suppressing one or more different frequency components of each of the interfering source signals to reduce noise.

2. The method of claim 1, wherein said suppressing includes extracting a desired signal representative of the desired source.

3. The method of claim 2, wherein said extracting includes determining a minimum
20 value as a function of the interfering signals.

4. The method of claim 1, wherein said localizing includes filtering with a number of coincidence patterns each corresponding to one of a number of predetermined spatial
25 positions relative to the first and second sensors, the patterns each providing phantom position information that varies with frequency relative to the one of the predetermined spatial positions.

5. The method of claim 1, further comprising delaying the first and second signals with a
30 different dual delay line for each of a number of frequencies to provide a corresponding number of delayed signals to perform said localizing.

6. The method of claim 5, further comprising processing the delayed signals after said localizing to perform said suppressing.

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7. The method of claim 6, further comprising:

transforming the first and second signals from a time domain form to a frequency domain form in terms of the frequencies before said delaying;

extracting a desired signal representative of the desired source, said extracting

5 including said suppressing;

transforming the desired signal from a frequency domain form to a time domain form;

and

generating an acoustic output representative of the desired source from the time domain form of the desired signal.

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8. The method of claim 5, wherein the interfering signals are each determined from a unique pair of the delayed signals as a ratio between a difference in magnitude of the unique pair of the delayed signals and a difference determined as a function of an amount of delay associated with each member of the unique pair of the delayed signals.

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9. A system, comprising:

a pair of spaced apart acoustic sensors each arranged to detect two or more differently located acoustic sources and correspondingly generate a pair of input signals, said acoustic sources including a desired source and a plurality of interfering sources;

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a delay operator responsive to said input signals to generate a number of delayed signals therefrom;

a localization operator responsive to said delayed signals to localize said interfering sources relative to location of said sensors and provide a plurality of interfering source signals each representative of a corresponding one of said interfering sources, said

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interfering source signals each being represented in terms of a plurality of frequency components, said components each corresponding to a different frequency;

an extraction operator responsive to said interfering source signals to suppress at least one of said frequency components of each of said interfering source signals and extract a desired signal corresponding to said desired source, said at least one of said frequency

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components being different for each of said interfering source signals; and

an output device responsive to said desired signal to provide an output corresponding to said desired source.

10. The system of claim 9, wherein said localization operator includes a filter to localize said interfering sources relative to a number of positions, said filter being based on a different coincidence pattern of ambiguous positional information that varies with frequency for each of said positions.

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11. The system of claim 9, further comprising:

an analog-to-digital converter responsive to said input signals to convert each of said input signals from an analog form to a digital form;

10 a first transformation stage responsive to said digital form of said input signals to transform said input signals from a time domain form to a frequency domain form in terms of a plurality of discrete frequencies, said delay operator including a dual delay line for each of the frequencies;

a second transformation stage responsive to said desired signal to transform said desired signal from a digital frequency domain form to a digital time domain form; and

15 a digital-to-analog converter responsive to said digital time domain form to convert said desired signal to an analog output form for said output device.

12. The system of claim 9, wherein said delay operator, said localization operator, and said extraction operator are provided by a solid state signal processing device.

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13. The system of claim 9, wherein said desired source signal is determined as a function of said interfering signals.

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14. The system of claim 9, wherein said interfering source signals are each determined from a unique pair of said delayed signals.

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15. The system of claim 14, wherein said interfering signals each correspond to a ratio between a difference in magnitude of said unique pair of said delayed signals and a difference determined as a function of an amount of delay associated with each member of said unique pair of said delayed signals.

16. The system of claim 9, wherein said output device is configured to provide an acoustic output representative of said desired source.

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17. A method, comprising:

positioning a first acoustic sensor and a second acoustic sensor to detect a plurality of
5 differently located acoustic sources;

generating a first signal corresponding to said sources with said first sensor and a
second signal corresponding to said sources with said second sensor;

providing a number of delayed signal pairs from the first and second signals, the
delayed signal pairs each corresponding to one of a number of positions relative to the first
10 and second sensors; and

localizing the sources as a function of the delayed signal pairs and a number of
coincidence patterns, the patterns each corresponding to one of the positions and
establishing an expected variation of acoustic source position information with frequency
attributable to a source at the one of the positions.

18. The method of claim 17, wherein the coincidence patterns each correspond to a
number of relationships characterizing a variation of phantom acoustic source position with
frequency, the relationships each corresponding to a different ambiguous phase multiple.

19. The method of claim 18, further comprising determining the relationships for each of
20 the coincidence patterns as a function of distance separating the first and second sensors.

20. The method of claim 18, wherein the relationships each correspond to a secondary
contour that curves in relation to a primary contour, the primary contour representing
25 frequency invariant acoustic source position information determined from the delayed
signal pair corresponding to the one of the positions.

21. The method of claim 17, wherein said localizing includes filtering with the
coincidence patterns to enhance true position information with phantom position
30 information.

22. The method of claim 21, wherein said localizing includes integrating over time and
integrating over frequency.

23. The method of claim 17, wherein the first sensor and second sensor are part of a hearing aid device and further comprising adjusting the delayed signal pairs with a head-related-transfer function.

24. The method of claim 17, further comprising:

extracting a desired signal after said localizing; and
suppressing a different set of frequency components for each of a selected number of the sources to reduce noise.

25. The method of claim 17, wherein the positions each correspond to an azimuth established relative to the first and second sensors and further comprising generating a map showing relative location of each of the sources.

26. A system, comprising:

a pair of spaced apart acoustic sensors each configured to generate a corresponding one of a pair of inputs signals, the signals being representative of a number of differently located acoustic sources;

a delay operator responsive to said input signals to generate a number of delayed signals each corresponding to one of a number of positions relative to said sensors;

a localization operator responsive to said delayed signals to determine a number of sound source localization signals from said delayed signals and a number of coincidence patterns, said patterns each corresponding to one of said positions and relating frequency varying sound source position information caused by ambiguous phase multiples to said one of said positions to improve sound source localization; and

an output device responsive to said localization signals to provide an output corresponding to at least one of said sources.

27. The system of claim 26, further comprising:

an analog-to-digital converter responsive to said input signals to convert each of said input signals from an analog form to a digital form; and

a first transformation stage responsive to said digital form of said input signals to transform said input signals from a time domain form to a frequency domain form in terms

of a plurality of discrete frequencies, said delay operator including a dual delay line for each of the frequencies.

28. The system of claim 27, further comprising:

an extraction operator responsive to said localization signals to extract a desired signal;

a second transformation stage responsive to said desired signal to transform said desired signal from a digital frequency domain form to a digital time domain form; and

a digital to analog converter responsive to said digital time domain form to convert said desired signal to an analog output form for said output device.

29. The system of claim 26, wherein said output device is configured to provide a map of acoustic source locations.

30. The system of claim 26, wherein said delay operator and said localization operator are defined by an integrated solid state signal processor.

31. The system of claim 26, wherein said localization operator responds to said delay signals to determine a closest one of said positions for one of said sources as a function of at least one of said delayed signals corresponding to said closest one of said positions and at least two other of said delayed signals corresponding to other of said positions, said at least two other of said delayed signals being determined with a corresponding one of said coincidence patterns.

32. A system, comprising:

a pair of spaced apart acoustic sensors each generating a corresponding one of a pair of inputs signals, the signals each being representative of a number of differently located sound sources;

a signal processor responsive to said sensors, said processor including: (a) a means for providing a number of delayed signals from said input signals, the delayed signals each corresponding to one of a number of positions relative to said first and second sensors; (b) a means for localizing each of said sound sources to one of said positions as a function of said delayed signals and a corresponding one of a number of patterns of frequency invariant data corresponding to one of said positions and frequency dependent data corresponding to at

least two other of said positions; (c) a means for suppressing a different frequency component of each of a selected number of said sources causing interference and for extracting a desired signal representative of one of said sources; and

5 an output device responsive to said desired signal to provide an output corresponding to said one of said sources.

33. The system of claim 32, wherein said processor includes a means for adjusting said delayed signals ~~with a head-related-transfer-function~~.

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